Current harvest rates of Central Valley chinook salmon stocks are high enough to adversely affect the natural production in some rivers and adversely affect naturally produced chinook salmon stocks. Accurate quantification of the Central Valley hatchery contribution to the ocean catch of chinook salmon has not been developed because of the lack of a consistent hatchery marking program in the Central Valley. Nonetheless, Dettman and Kelley (1987) estimated that from 1978 through 1984, an average of 11% of ocean catches off California comprised Feather River hatchery fish, and an average of 13% comprised American River hatchery fish. The percentage of annual contributions of hatchery fish to escapement in recent years has been estimated as follows:

- for the Feather River, 26% average for 1975-1987 (Cramer 1990) and 78% average for 1975-1984 (Dettman and Kelley 1987);
- for the American River, 29% average for 1975-1987 (Cramer 1990) and 86.6% average for 1975-1984 (Dettman and Kelley 1987);
- for the middle Sacramento River, 40% average for 1975-1987 (Cramer 1990); and
- for the upper Sacramento River, 41% average for 1975-1988 (Cramer 1990).

VISION

The vision for the artificial propagation of fish is to modify existing hatcheries and hatchery practices in ways to augment salmon and steelhead populations without having detrimental effects on naturally spawning populations of salmon and steelhead.

The existing level of reliance on artificially produced fish in the Central Valley is clear evidence that there are great deficiencies in the existing ecosystem processes that create and maintain habitat for anadromous fish. Extensive restoration activities will be required to shift the balance back to naturally produced fish populations.

The vision for the artificial propagation of fish is closely linked to ERPP visions for harvest, chinook salmon, steelhead trout, and striped bass. Cumulatively, these visions present a robust integration of production, harvest, and restoration targets and actions that will contribute substantially to restoring and maintaining a healthy ecosystem and healthy populations of valuable sport and commercial fisheries.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Three major programs to restore chinook salmon and steelhead populations exist within the Central Valley. The Secretary of the Interior is required by the Central Valley Project Improvement Act (Public Law 102-575) to double the natural production of Central Valley anadromous fish stocks by 2002 (USFWS 1995). The National Marine Fisheries Service is required under the federal Endangered Species Act to develop and implement a recovery plan for the endangered winter-run chinook salmon and to restore the stock to levels that will allow its removal from the list of endangered species. NMFS released this document in August 1997 (NMFS 1997). In August 1996, NMFS published a proposed rule to list tem Evolutionarily Significant Units west coast steelhead at threatened or endangered under the ESA. Included in this proposed rule was a proposal to list the Central Valley stock of steelhead as endangered. NMFS subsequently deferred list the Central Valley steelhead stock for six month due to scientific disagreement about the status of the stock.

The California Department of Fish and Game is required under State legislation (The Salmon, Steelhead Trout and Anadromous Fisheries Program Act of 1988) to double the numbers of salmon and steelhead trout that were present in the Central Valley in 1988 (Reynolds et al. 1993, McEwan and Jackson 1996).

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

One of the most important components of the ERPP is restoring health to fish populations in the ERPP Study Area. Some of these species, such as delta smelt and winter-run chinook salmon, are State or federally listed endangered species while others, such as splittail and steelhead, are species of concern. Artificial production programs in the ERPP Study Area need to be consistent with the principles of maintaining genetic diversity of natural stocks. These programs also need to be adaptive and implement operations to limit hatchery and wild fish interactions to reduce competition, predation, and the potential spread of diseases.

OBJECTIVE, TARGETS, ACTIONS, AND MEASURES

> The Strategic Objective is to ensure that chinook salmon, steelhead, trout, and striped bass hatchery, rearing, and planting programs do not have detrimental effects on wild populations of native species and ERP actions.

LONG-TERM OBJECTIVE: Develop a hatchery system and hatchery practices that truly augment salmon and steelhead populations without having detrimental effects on wild populations of salmon. Make sure that trout hatcheries and their associated planting programs do not interfere with or negate ERP actions.

SHORT-TERM OBJECTIVE: Evaluate closely all salmon and steelhead hatcheries and hatchery practices in the CALFED region to determine their effects on wild populations of salmon and steelhead. Take the first steps to change these practices if needed. Construct, where needed, additional artificial production capacity to augment salmon and steelhead using hatchery operation plans that avoid impacts to wild stocks and retain stock genetic integrity. Evaluate the trout hatchery and stocking program in California to determine its impact on populations of wild trout and other fish.

RATIONALE: The hatchery system in the Central Valley for salmon and steelhead was developed with the best of intentions, to maintain the fishery for these species that would otherwise be lost or severely depleted as the result of dams and diversions blocking access to spawning habitat. Hatcheries have generally succeeded by maintaining the commercial and sport fishery for chinook salmon, particularly fall-run chinook salmon. Regardless of the hatcheries, there has been a continued decline of other runs of salmon, of wild runs of fall-run chinook, and of native steelhead stocks. Salmon and steelhead originating from hatcheries may actually have aggravated this problem by interacting with wild fish and may have resulted in elevated harvest levels on those other runs of salmon and on wild fall-run in fisheries. A major emphasis of the CALFED ERP is to restore wild runs of salmon and steelhead by improving habitat conditions for them and by augmenting flows in spawning streams. The role that hatcheries, whether state, federal, or private (non-profit) can play in this recovery is uncertain. Recent strategies have focused on hatcheries that simply augment runs under poor hydrologic conditions when under pre-water development conditions a rivers system would have supported a much larger run. For severely depleted stocks hatchery rearing can provide a temporary insurance policy against extinction due to major natural and unnatural events. For more abundant stocks, however, hatcheries producing large numbers of salmon have the potential to confuse and contravene natural means. The role of hatcheries on every run of salmon and steelhead needs to be carefully evaluated to determine if and how hatchery practices should be changed.

State, federal, and private, have long attempted to satisfy angler demands for catchable trout by rearing domesticated fish for planting in streams, reservoirs, and lakes. There is little question that these planting programs are successful in providing angling for many people, especially in reservoirs and tailwaters of reservoirs. However, in some streams angling for domestic trout may put artificially high pressure on wild stocks of trout and steelhead or planting of domestic trout may introduce diseases to which other trout (and other organisms, including native frogs) are not immune. In some alpine lakes, regular plantings of trout are endangered native frog populations. There is thus a need to closely evaluate all trout stocking programs that take place in the CALFED area to make sure they are compatible with the CALFED goals.

STAGE 1 EXPECTATIONS: The role of every hatchery in the Central Valley in restoring salmon should be evaluated by an independent panel of experts. Where information is lacking, research programs should be conducted. Artificial propagation of salmon smolts of the San Joaquin basin as a research tool for designing and operating an augmentation hatchery that uses methods that do not conflict with restoring Central Valley salmon and steelhead. San Joaquin Basin artificial propagation will be providing needed juvenile salmon fry and smolts critical for adaptive management experiments on the San Joaquin River. A team of experts should be appointed to formally evaluate all aspects of the state and federal trout hatchery programs and issue recommendations in 1-2 years.

Restoration Actions

The general targets for the artificial production of fish are:

- propagation programs would be managed consistent with rehabilitation of chinook salmon and steelhead stocks and the conservation of ecological and genetic values;
- propagation programs would adopt a goal of maintaining the genetic diversity that exists between and within hatchery and naturally spawning populations;
- all artificially propagated fish should receive identifiable marks; and
- decision making about the uses of hatcheries and artificially propagated fish should occur within the context of a fully implemented adaptive management program that focuses on restoration of ecological processes and habitats, not simply the number and quality of fish successfully propagated.

MSCS Conservation Measures

The following conservation measures were included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets.

- Operate hatcheries such that the maintenance and expansion of natural populations are not threatened by the release of hatchery fish.
- Implement applicable management measures identified in the restoration plan for the Anadromous Fish Restoration Program and the recovery plan for the native fishes of the Sacramento/San Joaquin Delta.
- Implement management measures identified in the proposed recovery plan for the Sacramento River winter-run chinook salmon.

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INTRODUCTION

Stranding of juvenile and adult fish is a natural part of a healthy Central Valley ecosystem. Trapped fish provided a valuable source of protein and nutrients to several levels of the food chain, including mammals, avian predators and native peoples. Although stranding causes individual mortality, these losses historically would have been offset by strong in-channel production of the survivors. Stranding of fish in intermittent streams or floodplain areas represented part of the cost of maintaining a broad range, genetic diversity and access to potentially higher quality rearing habitat.

Although stranding was historically a natural event, today it is generally considered a stressor that contributes to the loss of important aquatic resources including adults and juveniles of important fishes. Anthropogenic changes to the valley and its tributaries have led to unnatural topography such as borrow ponds, which can trap large numbers of fish. Similarly, multiple stressors have led to declines in native fish populations, resulting in lower production to offset stranding losses. Efforts to reduce excessive stranding losses represent an important component in improving the natural production of Central Valley fish communities. Resolution of stranding in the Central Valley will require additional research and monitoring to better understand the scope of the problem and to identify key areas where stranding is a serious problem, and the implementation of experiments to refine restoration opportunities.

STRESSOR DESCRIPTION

Stranding appears to be of primary concern for migratory species such as chinook salmon, steelhead trout, sturgeon and splittail. This stressor is much less of an issue for nonnative game fish species such as largemouth and smallmouth bass, which frequently thrive in isolated ponds. Important mechanisms for stranding include: 1) stranding of adults and juveniles on bypass floodplains; 2) stranding of natal and non-natal juveniles within floodplains confined by setback levees; 3) stranding of salmonid redds as a result of flow fluctuation in river channels; and 4) stranding of migratory and resident species from Delta levee breaches.

FLOODPLAIN STRANDING ON BYPASSES

The region's largest floodplains are the Yolo and Sacramento bypasses, representing an integral parts the Sacramento Valley Flood Control System. Stranding principally occurs in wetter years, when fish mortality occurs as a result of predation, high temperature, dessication and perhaps disease or reduced oxygen levels. The Sacramento River, however, has overflowed into the Sutter Bypass every year since 1945, except during the 1977 drought, thus providing significant risk of fish mortality. Stranding is a problem in many drier years as well because weirs spill beginning at Sacramento River flows of only 30,000 cfs. The issue has been best-studied in the Yolo Bypass, a 59,000 acre engineered floodplain. Studies by California Department of Water Resources (1997, 1998a) showed that at least 40 species of fish use the basin during high flow events. Many of these fish are stranded when floodwaters recede. Notable examples of stranded juvenile fish include chinook salmon (fall-run, spring-run and winter-run size classes), steelhead trout, Sacramento splittail and Sacramento pikeminnow. Most of the same species are also present in the Sutter Bypass.

California Department of Water Resources (1997) identified three types of ponds in the Yolo Bypass where stranding occurs: 1) isolated ponds; 2) ponds that maintain some connection to the Delta; and 3) very shallow ponds, typically a few inches of water between row crops. Based on seining surveys and interpretation of aerial photographs, they provided a "ballpark" 1998 stranding estimate for the Yolo Bypass of 300,000-2 million juvenile salmon, depending on pond type. While this represents a substantial number of fish, results from 1998 sampling suggest that majority of young salmon successfully emigrate from the floodplain (California Department of Water Resources 1998a). Generally, emigration from certain types of overflow areas is relatively good because the land has been graded by farmers to drain properly. A contributing factor to the successful emigration is that Central Valley fish populations are probably adapted to take advantage of flood cycles. For example, there is evidence that growth of young salmon in the Yolo Bypass is superior to growth in the Sacramento River as a result of an abundant food supply and warmer water temperatures. Further evaluations are need, however, to determine if sampling bias affects the apparent higher growth rate. For example, when the bypass overflow stops, no additional fish are recruited into the bypass. Comparison of average size of stranded fish versus Sacramento River fish may be biased as there is continual recruitment of fish of all sizes, small and large, in the Sacramento River

This type of floodplain rearing may have been an integral part of the life history strategy for fall-run chinook and perhaps other salmon races. Additional evidence of the growth potential of bypass/floodplain areas was provided by the 1995-96 spring-run chinook salmon tagging study on upper Butte Creek (Hill 1996). Spring-run chinook fry tagged near Chico during January 1996 exhibited significant growth by the time they were recaptured downstream in the Sutter Bypass during March and April.

Recent studies (Maslin 1997 and 1998, Moore 1997) have demonstrated widespread non-natal use by juvenile salmonids of small upper Sacramento River tributaries, often finding fish several miles up the tributary from the river. Entry to these non-natal areas often occurs as the result of floodplain inundation with stranding occurring after flow recession and after low tributary flows sever the interconnectivity with the river. Preliminary results suggest that up to 10,000 winter-run chinook salmon were rearing in Mud Creek, a small tributary that joins Big Chico Creek near the Sacramento River (Maslin 1998). Such non-natal rearing was identified in 19 other small tributaries to the upper Sacramento River between Redding and Chico.

The California Department of Fish and Game has periodically rescued stranded adult chinook salmon in the ponded areas below the Tisdale, Colusa, and Moulton weirs. The magnitude of this stranding is not known as there is no consistent effort to identify stranding, and only easily accessible ponded areas are included in any rescue attempts. During April 1995, the California Department of Fish and Game rescued 74 adult spring-run chinook salmon from a pond located below the Moulton Weir (Meyer 1995).

Five overflow and recession events from the Sacramento River into the Sutter Bypass occurred between January 6 and May 15, 1995, thus providing significant opportunities for stranding. During that period, more that 50% of the entire upper Sacramento River flow was diverted through the Sutter Bypass. Stranding caused by the overflow weirs along the Sacramento River has not been systematically investigated. This source of stranding may be significant.

Additional areas where stranding needs further evaluation include managed and unmanaged wetlands, Liberty Island, Providence Island, lower Feather River floodplain, American basin, and many canals and ditches that have no connection to the rivers after overflow events.

California Department of Water Resources (1997 and unpublished data) note several locations in the Yolo Bypass where stranding rates could be reduced using relatively simple techniques. One example is Sacramento Weir, where leaky flashboards divert fish from the Sacramento River onto the Sacramento Bypass ponds, resulting in stranding rates approximately an order of magnitude higher than any other Yolo Bypass location. Similarly, adult spring run salmon, striped bass and sturgeon are stranded in deeper ponds and channels in part as a result of an outdated, inefficient fish ladder located at Fremont Weir, the upstream limit of the Yolo Bypass. Although the magnitude of this problem has not been documented, the fact that there is a popular sport fishery after the Yolo Bypass recedes suggests that fairly large numbers of adults are stranded. Both the Sacramento and Fremont Weir problems could be fixed or at least improved with fairly minor structural changes.

Stranding of Young Fish Within Floodplains Confined by Set Back Levees

Juvenile and adult fish are also stranded in floodplains adjacent to river channels. For the major rivers of the Central Valley, these floodplains are confined by set back levees. Examples include the Feather, Yuba, American, Mokelumne, Stanislaus and Tuolumne rivers. Fish stranded in these areas a subject to similar sources of mortality as for the bypasses. The level of stranding dependents on fish population levels, topography and the timing and magnitude of flow fluctuation.

In the Feather River, California Department of Water Resources (1998b) studied the effects of a relatively minor winter flow reduction (less than 10 percent) on stranding rates. They concluded that the relatively small numbers of salmon were stranded in depressions on gravel bars below Thermalito Afterbay Outlet were not biologically significant. The low stranding rates were consistent with instream flow model results, which predicted only minor ponding from the flow change. California Department of Fish and Game (1991) used similar instream flow methods for the Mokelumne River and that minor flow fluctuations resulted in little stranding area provided that discharge levels remained above 400 cfs.

Major flow fluctuations distribute fish over a much broader area, frequently exposing them to more variable topography and longer migration path to return to the channel. Whereas minor flow fluctuations occur in all water year types, large scale flow changes are most common in above normal to wet years. In contrast to the low numbers of salmon found in January 1998 in the Feather River below Thermalito Afterbay Outlet following a minor flow fluctuation, in April 1998 Jones and Stokes Associates (unpublished data) found thousands of young salmon in shallow ponds on a broad, downstream floodplain located near Nelson Slough following major flood releases in the Feather River. Fish trapped in these types of ponds may thrive if later flow pulses provide an escape route.

Stranding mortality rates are probably highest in gravel pits, borrow ponds, and spoil deposition areas. Large scale aggregate mining has been conducted for decades in Valley rivers such as the Feather, Tuolumne and Stanislaus rivers. Aggregate mines historically extracted sand and gravel from both the river channel and its adjacent floodplain. Older mines were usually created directly in the channel, creating large depressions. Some remain within the active channels of rivers such as the Tuolumne River. Both in-channel and floodplain ponds can become connected to the main channel during high flow events. These pits support warmwater predators such as largemouth and smallmouth bass that prey on juvenile salmon that migrate through the pits and become trapped after floodwaters recede. Similarly, gold mining activities resulted in dredging and deposition of tailings, converting large areas of floodplain habitat to variegated landscapes with sloughs and borrow ponds that trap migrating salmon and other fish during periods of high water.

Adult Stranding in River Channels

In the Central Valley, steelhead trout and most races of chinook salmon spawn in late summer or autumn. If flows are reduced substantially during the next three months, redds may be isolated, resulting in egg mortality from low oxygen levels or dessication. Although many Central Valley rivers have streamflow fluctuation requirements during critical periods for salmon, unusual spawning events may put fish at risk. For example, in 1991 flow fluctuations from water transfers on the Yuba River led to the stranding or isolation of hundreds of fall-run adult salmon which spawned much earlier than expected.

Stranding of Migratory and Resident Species from Delta Levee Breaches

Delta islands regularly breach in very wet years as a result of land subsidence and antiquated levees. Breaches essentially create a large-scale diversion that can draw thousands of acre-feet of water and fish onto Delta islands. Levees are generally repaired while or after the islands are emptied. During drainage fish are either stranded or pass through hazardous pumps. The magnitude of this problem has not been quantified, however accounts of extensive fish stranding during the 1996 draining of Prospect Island following a levee breach suggest that mortality can be substantial. This type of stranding is also a problem in Feather, American, and Cosumnes floodplains as well as in the Natomas Cross Channel, north of Sacramento.

VISION

The vision for stranding is to reduce the magnitude of the number of aquatic organisms lost when rivers recede or overflow into flood bypasses and to reconnect areas that become isolated with flowing water and to reduce the frequency by which low-lying areas are inundated.

The vision includes improving the structure of channels and floodplains and stabilizing flows during critical periods. Achieving this vision would help to maintain or restore riparian and floodplain habitat and sustain streamflow levels that would improve fish spawning, rearing and emigration.

For bypass floodplains, the strategy is to improve drainage to allow young fish to emigrate and to modify weirs that strand juvenile fish or create passage problems for adults after floodwaters recede. Options to achieve this would be through the construction of year-round low flow channels for drainage and fish passage and the construction of fish ladders to permit upstream passage of adult fish. The focus for these actions would be the Yolo and Sutter bypasses, including the overflow weirs and bypasses which connect them to the river and which comprise the Sacramento Valley's engineered floodplains. In riparian and floodplain areas between river channels and set back levees, restoration activities would emphasize recontouring of poorly-drained areas heavily impacted by historical mining activities. Where possible, gravel and borrow ponds that connect to the main channel during high water periods would be removed or filled. Many borrow ponds provide good habitat during much of the year for a variety of aquatic dependent species and the preferred means to reduce stranding losses is to create and maintain connections with the rivers and streams. Alternatively, levees would be improved or constructed to keep these ponds separated from the active channel. In addition, flows in the smaller non-natal tributaries should be maintained as much as possible to allow positive avenues of escape for rearing juveniles. Stranding of adult spawners and their redds could be avoided by reducing flow fluctuations during critical time periods. Stranding losses from Delta levee breaks would be reduced through levee improvements or conversion of flood-prone islands to tidal wetlands and shallow water habitat.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Efforts to reduce stranding will involve the cooperation and support of established programs underway to restore habitat and fish populations in the basin:

- The Central Valley Project Improvement Act (CVPIA) calls for doubling of the anadromous fish populations (including striped bass, salmon, steelhead, sturgeon and American shad) by 2002 through changes in flow, project facilities and operations. The program involves actions that may reduce stranding rates through habitat or flow improvements.
- The California Department of Fish and Game is required under State Legislation (The Salmon, Steelhead, Trout and Anadromous Fisheries Program Act of 1988) to restore numbers of anadromous fish in the Central Valley.
- The Four Pumps and Tracy Fish Mitigation Agreements. These two agreements involve mitigation in the Sacramento and San Joaquin basins to offset fish losses at the SWP and CVP pumping plants. Restoration projects in these programs frequently deal directly or indirectly with fish stranding issues.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Reducing stranding is linked to restoration of riparian, floodplain and riverine aquatic habitats and creation of set back levees. Population effects of stranding losses will be mitigated by efforts to reduce stressors to resident and migratory fish. For example, reducing levels of invasive aquatic organisms, reducing predation and competition, gravel restoration, screening of water diversions and reducing levels of toxins should help to improve fish population levels to offset unavoidable stranding losses.

OBJECTIVE, TARGETS, ACTIONS, AND MEASURES

> The Strategic Objective for stranding is to reestablish frequent inundation of floodplains by removing, breaching, or setting back levees and, in regulated rivers, by providing flow releases capable of inundating floodplains were feasible.

LONG-TERM OBJECTIVE: Implement a comprehensive program to reduce stranding effects in the Delta and its tributary streams.

SHORT-TERM OBJECTIVE: Reduce the adverse effects of stranding by physical modifications to problem areas and, where feasible, implementation of flow schedules that minimize adult stranding.

RATIONALE: Recontouring of floodplains including removing or isolating borrow ponds should promote successful emigration of fish following high water events and create valuable rearing habitat at the river margins. Improving at bypass weirs would eliminate diversion of fish onto floodplain ponds by leaky flashboards and provide for adult upstream passage. Reducing flow fluctuations during spawning periods would help to avoid losses of adults and eggs. Stranding losses from Delta levee breaks would be reduced through levee improvements or conversion of flood-prone islands to tidal wetlands and shallow water habitat.

STAGE 1 EXPECTATION: Initial assessments will be completed of the potential for stranding of juvenile and adult fish in the floodplains and bypasses in the Central Valley. Small-scale adaptive experimentation projects will be implemented to reduce the potential losses due to stranding and to increase the value of bypasses as rearing habitat for splittail and juvenile chinook salmon.

RESTORATION ACTIONS

Actions which can contribute to this vision for bypass floodplains include:

- Improving drainage to allow young fish to emigrate. For example, check boxes could be installed in fields with low levees that border the drains for the Yolo and Sutter bypasses.
- Modifying Sacramento Weir to eliminate leakage through flashboards.
- Constructing a fish ladder at Fremont Weir and provide permanent flow to facilitate adult upstream passage.
- Constructing of a permanent low flow channel through the Yolo Bypass to improve adult passage and drainage following flow events.
- Constructing permanent low flow channels through the Moulton and Colusa bypasses.
- Investigating the potential to develop permanent low flow channels connecting the M&T, 3-B's, and Goose Lake overflow structures with Butte Creek and the Sutter Bypass.
- Developing maintenance flows to provide extended interconnectivity of upper Sacramento River non-natal rearing tributaries.

Actions which can contribute to this vision for floodplains within setback levees include:

- Recontouring heavily corrugated landscapes to improve drainage to the river channel.
- Filling gravel and borrow ponds that connect to the main channel during high water periods or, preferably, creating connectors to allow fish to migrate from ponds into the river.
- for large ponds that are uneconomical to fill, constructing or improving levees to isolate these areas from the active river channel.

Actions which can contribute to this vision for adult spawning include:

- reducing flow fluctuations during critical time periods for adult spawning and egg incubation.

Actions which can contribute to this vision for Delta islands include:

- improving levees to reduce the probability of breakage.
- converting flood-prone islands to tidal wetlands and shallow water habitat.

MSCS Conservation Measures

The following conservation measures were included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets.

- Implement applicable management measures identified in the restoration plan for the Anadromous Fish Restoration Program and the recovery plan for the native fishes of the Sacramento/San Joaquin Delta.
- Implement management measures identified in the proposed recovery plan for the Sacramento River winter-run chinook salmon.
- To the extent consistent with CALFED objectives, minimize flow fluctuations to reduce or avoid stranding of juvenile steelhead.
- To the extent consistent with CALFED objectives, design and construct overflow basins from existing leveed lands in stages using construction design and operating schemes and procedures developed through pilot studies and project experience to minimize the potential for stranding as waters recede from overflow areas.
- To the extend practicable, design seasonal wetlands that have hydrological connectivity with occupied channels to reduce the likelihood for stranding splittail and to provide the structural conditions necessary for spawning.

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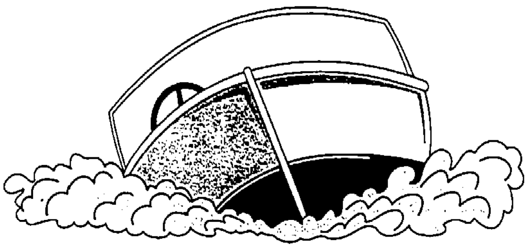

INTRODUCTION

Disturbance resulting from human activities can adversely affect habitat for a substantial variety of fish, wildlife, and plant communities including many special-status species and plant communities listed as endangered or threatened on the California and federal Endangered Species Acts (ESAs) lists. The types of disturbance include those associated with recreational boating, angling and picnicking, airplane and vehicle traffic, and the secondary effects of residential development adjacent to wildlife habitat

The Ecosystem Restoration Program Plan (ERPP) proposes to reduce disturbance where species, such as the Swainson's hawk, nest. Establishing habitat buffers around sensitive habitat or wildlife use areas (e.g., Swainson's hawk nest sites) screens wildlife from disturbance associated with motor vehicle traffic and reduces recreation-related disturbance while still allowing for careful wildlife observation activities.

Carefully designing recreational access points can also reduce the level of disturbance on wildlife (e.g., locating access points to avoid impacts to levees and to keep trespassing and vandalism of private lands to a minimum).

The vision includes providing opportunities for recreational boating in a manner that reduces the impacts of those activities on fish and wildlife. This could be achieved by improving recreational boating opportunities in selected areas of the Delta for both motorized and non-motorized craft while reducing or eliminating boating by closing sensitive biological areas during specific seasons.

STRESSOR DESCRIPTION

Recreational boating is a popular activity in the ERPP study area, particularly in the Sacramento-San Joaquin Delta and Suisun Marsh/North San Francisco Bay Ecological Management Zones. Boating activities include the use of small, human-powered craft, such as canoes and kayaks, and individual motorized craft such as jet skis, sail boats, boats ranging from small fishing skiffs to ski boats, and larger pleasure craft. Wind surfing is also expanding in popularity. Excessive, unrestricted boating activities can result in increased erosion of adjacent channel banks, increased turbidity, and conflicts with other boat operators using the same channels.

Angling and picnicking are also popular activities. Unrestricted human entry for these and other activities has contributed to levee degradation in the Delta, littering, and wildfires and can increase the likelihood of trespass and vandalism on private lands.

Vehicle traffic close to wildlife habitat reduces the value of that habitat to wildlife, particularly to species such as the greater sandhill crane. Aircraft traffic (both fixed-wing and helicopter) associated with the application of agricultural chemicals can also contribute to the disturbance of wildlife in the Delta.

Disturbance associated with the pets of people who live near wildlife habitat can result in harassment of wildlife, particularly ground-nesting birds.

VISION

The vision for disturbance is to reduce the adverse effects of boating and other recreational activities, temporary habitat disturbances, and other human activities on wildlife and their habitats in the Bay-Delta.

ERPP's general approach to achieving the vision for this stressor will be to ensure that the location of restored habitat takes into account adjacent land uses, that adequate buffer areas to protect against disturbance are used, and that recreational activities are managed to avoid or minimize conflicts with fish and wildlife habitat. Recreationists should be provided with adequate facilities in areas that are not sensitive to fish and wildlife and where trespass onto adjacent private lands can be avoided.

INTEGRATION WITH OTHER RESTORATION PROGRAMS

Agencies charged with regulating activities within their respective jurisdictions include the U.S. Coast Guard, California Department of Boating and Waterways, California Department of Parks and Recreation, local park districts such as the East Bay Municipal Parks District, local sheriffs in the affected counties, California Department of Fish and Game, California Department of Water Resources, and U.S. Fish and Wildlife Service.

LINKAGE WITH OTHER ECOSYSTEM ELEMENTS

Human caused disturbance adversely affects habitats and species. Boat wake shoreline erosion can impair ERPP efforts to protect and restore shoreline vegetation and shallow water emergent vegetation, particularly in the Delta and along the mainstem Sacramento and San Joaquin Rivers. Human presence can also disturb populations of special status fish, wildlife, and plant species.

OBJECTIVE, TARGETS, ACTIONS, AND MEASURES

The Strategic Objective for disturbance is to contribute to the recovery of at-risk native species in Bay-Delta estuary and its watershed.

LONG-TERM OBJECTIVE: Eliminate or greatly reduce the adverse influence of human-induced disturbance on important fish and wildlife species by controlling access during critical times.

SHORT-TERM OBJECTIVE: Evaluate the location of public use access sites to identify potential site that may adversely influence fish and wildlife populations and identify alternative sites for public access that will reduce human-wildlife interactions.

RATIONALE: Some of the species that are known to be adversely influenced by human-induced disturbance include Swainson's hawk, California black rail, California clapper rail, greater sandhill crane, and spring-run chinook salmon. Restoration elements for these example species are strongly directed at restoring or improving habitat for nesting or spawning, forage, loafing, and other habitats required for successful completion of their life cycles. These species are particularly susceptible to disturbance during critical segments of their life cycle, especially those related to reproduction such as nesting and spawning. Reducing human disturbance is an integral component to restoring these and similar species.

STAGE 1 EXPECTATIONS: Surveys will have been completed that identify critical areas and critical times for fully protecting species that are vulnerable to human-induced disturbance. This information will have been used in refining and implementing restoration actions and in identifying sites that can be developed for recreational and public uses.

RESTORATION ACTIONS

The following approaches would help achieve this vision:

- Cooperate with agencies responsible for managing the State's recreational activities to ensure properly sized and sited facilities will be provided and maintained.
- Cooperate with the Department of Boating and Waterways, U.S. Coast Guard, and local mariner organizations to identify the need and feasibility of, and implement where feasible, seasonal boating closures in sensitive wildlife use areas while maintaining alternative boating opportunities.

MSCS CONSERVATION MEASURE

The following conservation measure was included in the Multi-Species Conservation Strategy (2000) to provide additional detail to ERP actions that would help achieve species habitat or population targets.

- Manage enhanced and restored habitat areas to avoid or minimize potential impacts associated with recreational uses on lands acquired or managed under conservation easements on the saltmarsh common yellowthroat.

REFERENCES

Multi-Species Conservation Strategy. 2000. CALFED Bay-Delta Program, Programmatic EIS/EIR Technical Appendix. July 2000.

Strategic Plan for Ecosystem Restoration. 2000. CALFED Bay-Delta Program, Programmatic EIS/EIR Technical Appendix. July 2000.